spectroscopy/

This dataset contains the following subdirectories with data in the

Raw/

File	Object	Exposure (sec)	Grism
wa220035.fits	Ison comet	1200.00	Grism 7
wa220036.fits	Ison comet	1200.00	Grism 8
wa220037.fits	Fe-Ne lamp	13.00	Grism 8
wa220038.fits	Fe-Ar lamp	6.00	Grism 7
wa220040.fits	bias_snspec	0.000	None
wa220041.fits	bias_snspec	0.000	None
wa220045.fits	HR1544	10.00	Grism 7
wa220046.fits	HR1544	10.00	Grism 8
wa220049.fits	FeNe lamp	5.00	Grism 8
wa220050.fits	FeNe lamp	10.00	Grism 7
wa220051.fits	bias_snspec	0.000	None
wa220052.fits	bias_snspec	0.000	None
wa220053.fits	bias_snspec	0.000	None

Processed/

File	Object	Exposure (sec)	Grism
CometGr7_spectrum.fits	Ison comet	1200.00	Grism 7
ContinuumGr7.fits	Ison comet	1200.00	Grism 7
MasterFlat.fits	Halogen lamp	6.00	Grism 7
SolarAnalogGr7.fits	HD195034	5.00	Grism 7

Derived/

'ison_spectrum.txt' is the text file of wavelength calibrated comet spectrum. The first column is the wavelength in angstrom, the second column is the relative flux of the comet.

'ison_continuum.txt' is the text file of comet continuum obtained from the file CometGr7_spectrum.fits. The first column is the wavelength in angstrom, the second column is the normalized continuum flux of the comet.

'ison_continuum_subtracted.txt' is the text file of the continuum-subtracted spectrum of the comet. The first column is the wavelength in angstrom, the second column is relative normalized flux.

'solar_analog.txt' is the text file of solar analog star HD195034 spectrum. The first column is the wavelength in angstrom, the second column is the relative flux of the solar analog.

'solar_continuum.txt' is the text file of solar continuum obtained from the solar analog star HD195034 spectrum. The first column is the wavelength in angstrom, the second column is the normalized flux of the solar analog.

'albedo.txt' is the text file of the reflectance of the comet. The first column is the wavelength in angstrom, the second column is the reflectance value. The reflectance spectrum is obtained by dividing the comet continuum with that of a solar continuum, obtained from the solar analog star HD195034 spectrum.

HFOSC CCD.

The data was taken on **2013-01-22** using the Himalayan Faint Object Spectrograph and Camera (HFOSC) mounted on the 2.0 m telescope (HCT) of the Indian Astrophysical Observatory (IAO) of the Indian Institute of Astrophysics (IIA), located at 4500 m above sea level, Hanle, Leh, Ladakh.

HFOSC is equipped with a Thompson CCD of 2048x2048 pixels with a pixel scale of 0.296"/pix and a field of view of ~10x10 arcmin. The readout noise, gain and readout time of the CCD are 4.87 e, 1.22 e/ADU, and 90 sec, respectively. Spectroscopy was performed using a slit width of 1.92 arc-sec, and Grisms 7 and 8 with resolution $\lambda/\Delta\lambda$ = 1330 for Gr7, and 2190 for Gr8, and bandwidth coverage of 0.38–0.64 μm and 0.58–0.84 μm, for Grisms 7 and 8, respectively. All the spectra are provided here were taken in the *sn-spec* mode. In this mode, the data is binned by a factor of two, along the cross-dispersion axis. For faint, and extended faint objects, this allows for a higher S/N in each pixel, but compresses the dimension of the object along the slit by a factor of two.

Details of the grisms used are as follows:

Instrument/ Telescope	Frame size px	Slit Dimension WxL	Dispersion Å/px	Range Å	Resolution Å
Gr7/ HCT	500×3500	1°.92×11'	1.45	3800--6840	10
Gr 8/HCT	500×3500	1°.92×11'	1.45	5800--8300	10

Reduction Procedure.

The spectroscopic data preprocessing was performed using standard routines of the IRAF software by bias subtraction and flat-fielding using the halogen lamp spectra. Since no spectroscopic flats (halogen lamp exposures) were available at early epochs of comet observations (January and May), we used multiple spectroscopic flats and biases taken on two later dates: **2013-09-29** and **2013-10-01**, to construct the Master Flat. The gain and readout noise on each of these nights were calculated using the photometric sky flats (with average count/pixel = 30,000 to 40,000) and biases taken on the same night by the IRAF utility *findgain*. As the HCT/*HFOSC* has several regions of bad pixels/hot pixels and other flaws, an average value of these parameters, determined from sections of the CCD with no bright field stars or hot/bad pixels, was used in the subsequent analysis. On both nights, for each slit and grism combination used here, Grism7/167 and Grism8/167l, spectroscopic flats along with spectroscopic biases, were taken with a halogen lamp. The position of the slit on the CCD is fixed and does not change from night to night. For each night, the multiple spectroscopic biases were combined using the IRAF utility *zerocombine* (an average value is taken for each pixel, after using a minmax algorithm for cosmic-ray rejection). The combined Master Bias was subtracted from each halogen lamp spectrum. The latter were then combined using IRAF utility *flatcombine* (average combine with an average sigma clipping factor of +/- 3 to reject cosmic rays), to give a spectroscopic Master Flat. A response function of type spline3, order 25, was fitted to the segment of this Master Flat from which useful spectroscopic data would be extracted (i.e lines 200 to 3000 along the dispersion axis). The IRAF utility *response* used this response function to produce the final, normalized spectroscopic Master Flat.

1-D spectra was obtained using the *apall* function in IRAF with multispec format. This algorithm allows us to (*a*) track and make a polynomial fit to the dispersion axis on the CCD, (*b*) extract a 1-D target spectrum from a region +/- 10 pixels around the optocenter (maximum of light) at each point on the dispersion axis, (*c*) estimate the local background at each point along the dispersion axis, and (*d*) to subtract the modelled background from the raw spectrum. The local background here was obtained by a single polynomial fit to two regions, each 50 pixels wide, located +/- *Y* pixels on either side of the dispersion axis.

Reduction of the solar analog star HD195034 spectrum, observed on **2014-05-31**, followed the same routine; the solar analog spectrum was used for deriving the reflectance spectrum.

Derived Spectra.

Because S/N for Grism8 spectra was very low, we have extracted only Grism7 spectra. Wavelength calibration was performed using Fe-Ar lamp spectrum. Since the seeing was very poor on that night and there were thin clouds, overall the number of counts was quite low, therefore the comet spectrum had to been heavily smoothed to reduce the noisy appearance using the boxcar smoothing parameter set at 19. The wavelength-calibrated comet and solar analog spectra were fitted with a 3rd order polynomial function in IRAF using the *continuum function* to obtain the spectra of comet and solar continuum. The continuum spectra were then normalized by dividing by the maximum value to obtain the normalized continuum spectra. To obtain the continuum-subtracted relative comet flux, first the wavelength-calibrated comet spectrum was divided by the spectrum of the continuum, and then the normalized continuum was subtracted from the result. The reflectance spectrum was obtained by dividing the normalized comet continuum with the normalized solar analog continuum.

The first figure shows the variation of reflectance with wavelength. Black line: normalized continuum of ISON spectrum; Red line: normalized continuum of solar spectrum; Green line: normalized ratio of both.
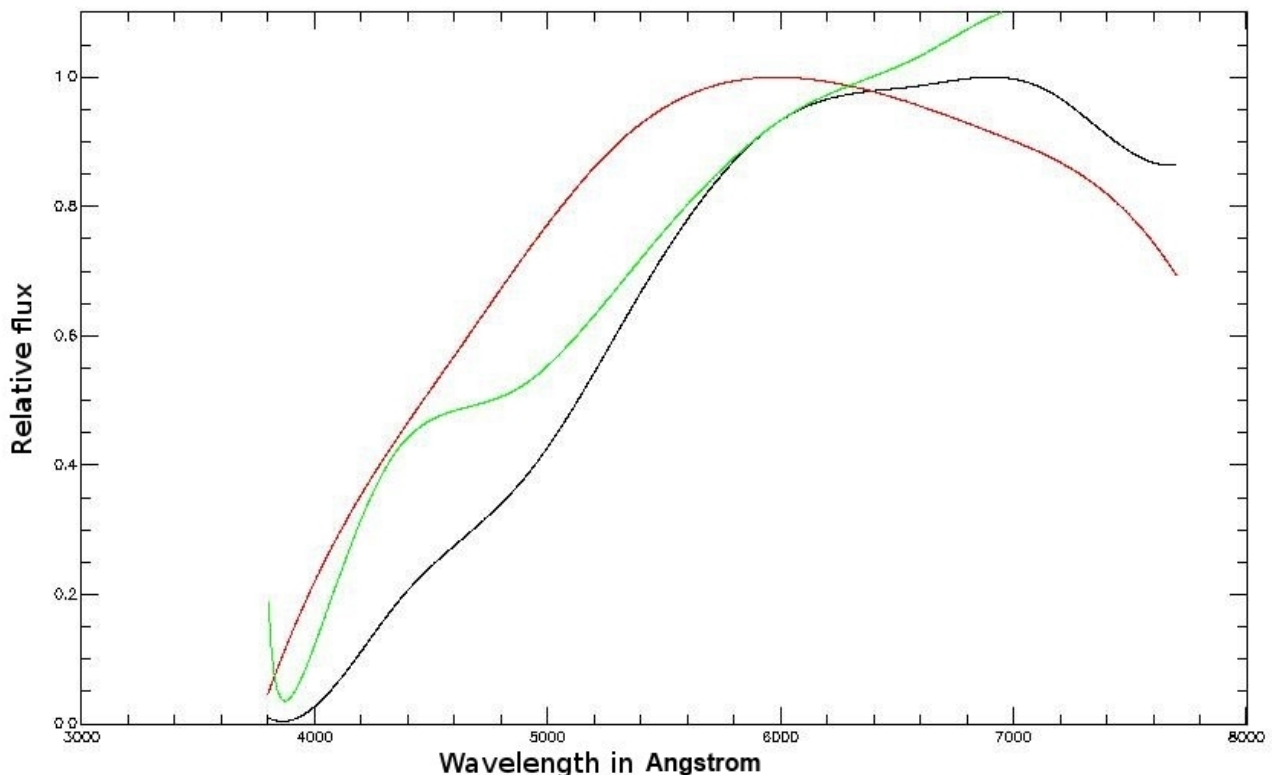
The second figure represents the variation of comet continuum-subtracted relative flux with wavelength.